Carbon Cycle 2.0

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Carbon Cycle 2.0 LDRD Seminar Series is a weekly seminar series hosted by Berkeley Lab's Carbon Cycle 2.0 Iniative. Seminars are given by recipients of Laboratory Directed Research and Development (LDRD) awards related to climate and energy. These seminars are open to anyone interested in learning more about the wide variety of Carbon Cycle 2.0-themed research at Berkeley Lab.

Artificial Photosynthesis and Novel Photovoltaics

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WHEN: THURSDAY, JUNE 30, 2PM - 3PM
WHERE: BUILDING 15 ROOM 253

A practical method to use sunlight to generate liquid transportation fuels would yield a carbon-neutral energy source which could dramatically change the landscape of global energy generation. The fundamental steps involved in developing such an "artificial photosynthesis" scheme will be discussed, along with the scientific barriers which have prevented development of a feasible system to date.

At LBNL, an approach based on inorganic light absorbers coupled to oxidation and reduction catalysts is being developed in the Joint Center for Artificial Photosynthesis (JCAP). This presentation will focus on the photovoltaic (PV) element of the fuel generating system. These PV systems are designed to provide the electrical driving force to enable catalysts to perform the desired oxidation and reduction chemistry. We are concentrating on photoanodes (O2 producing) and photocathodes (H2 or hydrocarbon producing) which can be formed from abundant elements with inexpensive and scalable processes. While the thermodynamic minimum voltage required for photochemical water splitting into H2 and O2 is 1.23 V, in practice higher voltages are required to produce acceptable reaction rates (the constraints for reducing CO2 to methanol or to methane are similar).

Two specific examples of PV approaches which can produce the required voltage for water splitting will be discussed. (1) An "aliovalent" alloy of GaN and ZnO is one of the few materials which has been reported to sustain spontaneous water splitting under visible illumination. Insights into the nature of the reduced bandgap compared to that of the endpoint compounds and efforts to synthesis and characterize the related AlN1-xZnOx system will be presented. (2) In a CC 2.0 LDRD project the origin of a new PV effect which occurs at the "domain walls" between regions of differing electrical polarizations in ferroelectric BiFeO3 is being investigated. Although the voltage generated by each domain wall is small, ca. 10 mV, the voltages can add in series, as in a tandem solar cell, so that a voltage of any chemically relevant magnitude can be produced. We have demonstrated photovoltages exceeding 10 V with a quantum efficiency per domain wall approaching 50%.